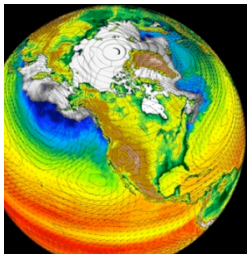
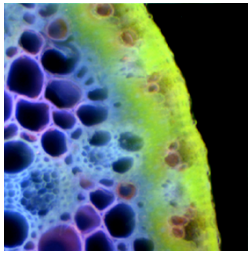
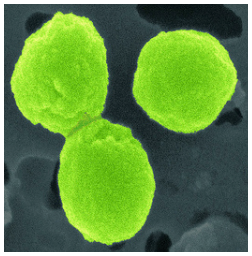


Biological and Environmental Research

David Thomassen, Ph.D.
Chief Scientist
Office of Biological and Environmental Research

Biological and Environmental Research Mission

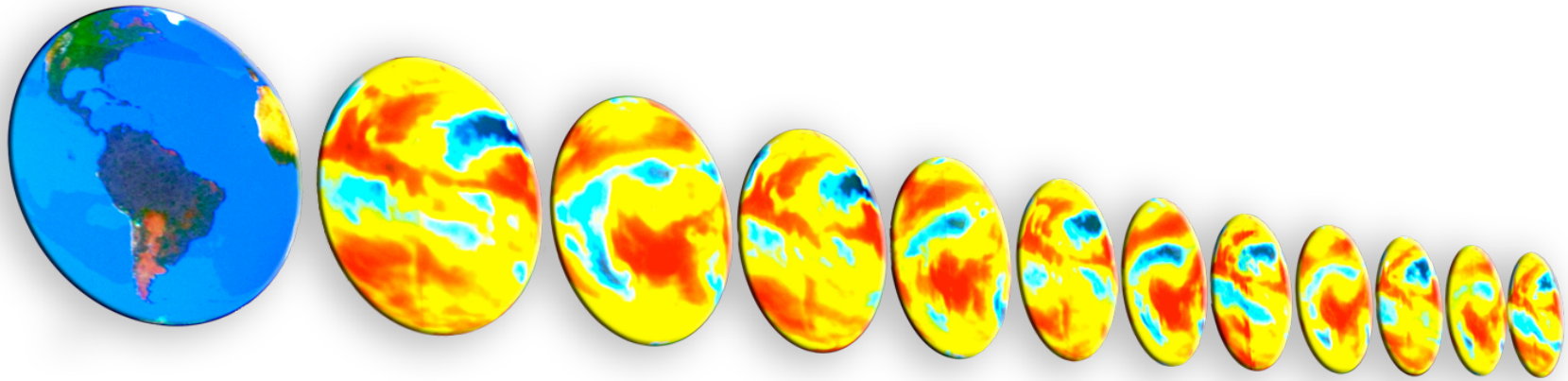
- To understand complex biological, climatic, and environmental systems across spatial and temporal scales by:
  - Exploring the frontiers of genome-enabled biology
  - Discovering the physical, chemical, and biological drivers and impacts of climate change
  - Seeking the geochemical, hydrological, and biological determinants of environmental sustainability and stewardship

Biological and Environmental Research Mission drivers

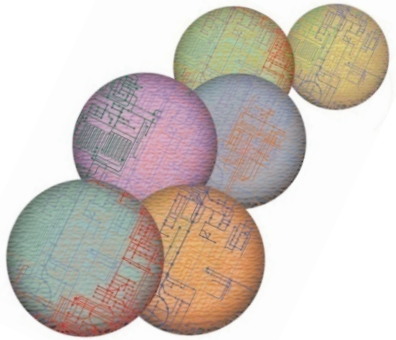
- Provide the foundational science for:
  - Supporting the development of biofuels as major, secure, and sustainable national energy resources
  - Understanding potential effects of greenhouse gas emissions on Earth's climate and biosphere and the implications of these emissions for our energy future
  - Predicting the fate and transport of contaminants in the subsurface environment at DOE sites
  - Developing new tools to explore the interface of biological and physical sciences

Biological and Environmental Research Approach

- Understanding complex biological and environmental systems across many spatial and temporal scales:
  - From the sub-micron to the global
  - From individual molecules to ecosystems
  - From nanoseconds to millennia
- Integrating science by tightly coupling theory, observations, experiments, models, and simulations
- Supporting interdisciplinary research to address critical national needs
- Engaging national laboratories, universities, and the private sector to generate the best possible science

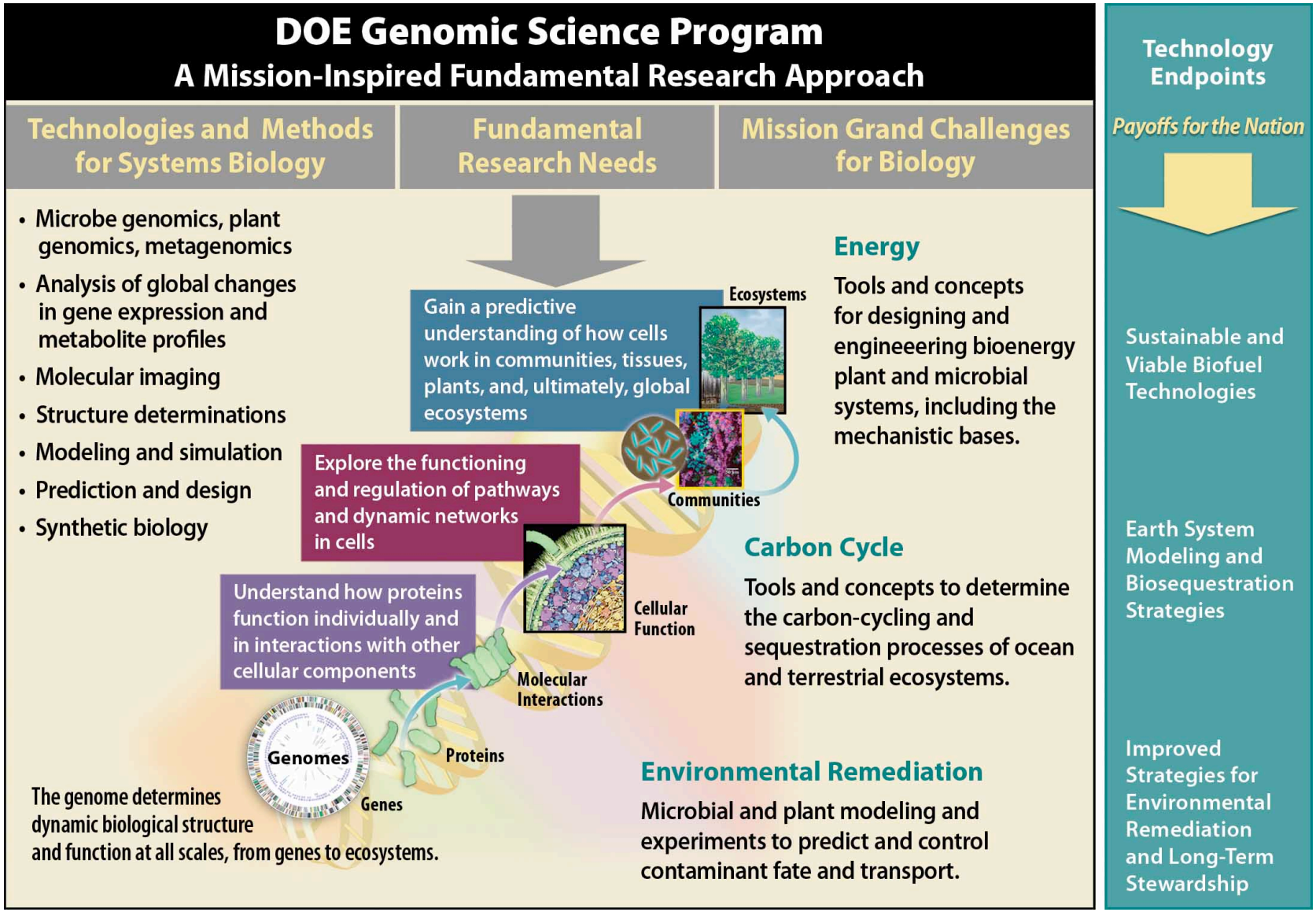


Genomics:GTL
A vision of systems biology research



- Within 10 years, we will start with a plant, microbe, or microbial community of interest and in a matter of a few days for microbes or years for plants:
  - Fully and accurately annotate genome or community DNA
  - Identify the functions and products of the majority of genes
  - Generate a working regulatory network model
  - Identify the biochemical capabilities of the organisms
  - Design re-engineering or control strategies *in silico*
  - Redesign or refocus an organism for mission-critical needs
- Today, almost all of these activities take months to decades!

Genomic Science Program



Joint Genome Institute and Bioenergy

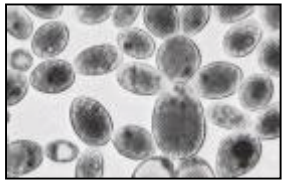
Improved feedstocks

Cellulosic Materials

- **Poplar**
- **Maize and corn stover**
- **Switchgrass**
- ***Brachypodium***
- **Sorghum**



Saccharification → **Sugars** → Fermentation

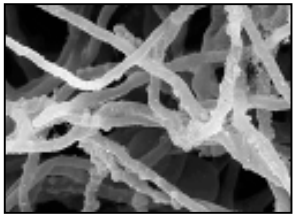


- ***Saccharomyces cerevisiae***
- ***Zymomonas mobilis***
- ***Thermoanaerobacter ethanolicus***
- ***Pichia stipitis***

Ethanol-producing organisms

Improved cellulose and lignin degradation

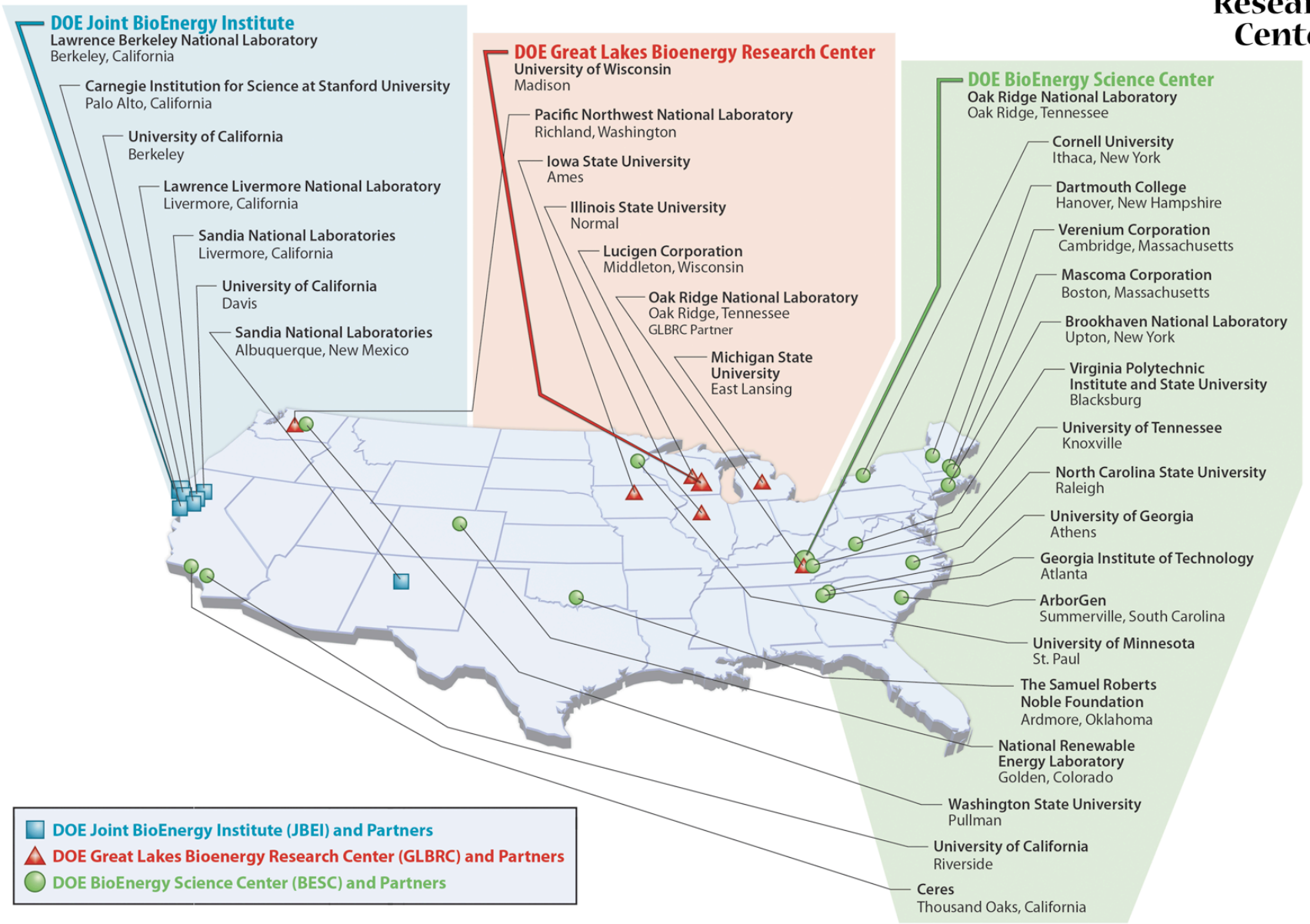
- **Termite hindgut microbiota**
- **White rot fungus**
- ***Clostridium thermocellum***
- ***Saccharophagus degradans***
- ***Acidothermus cellulolyticus***

DOE Bioenergy Research Centers

Multi-institutional partnerships

DOE Bioenergy Research Centers



Terrestrial Carbon & Carbon Sequestration Programs

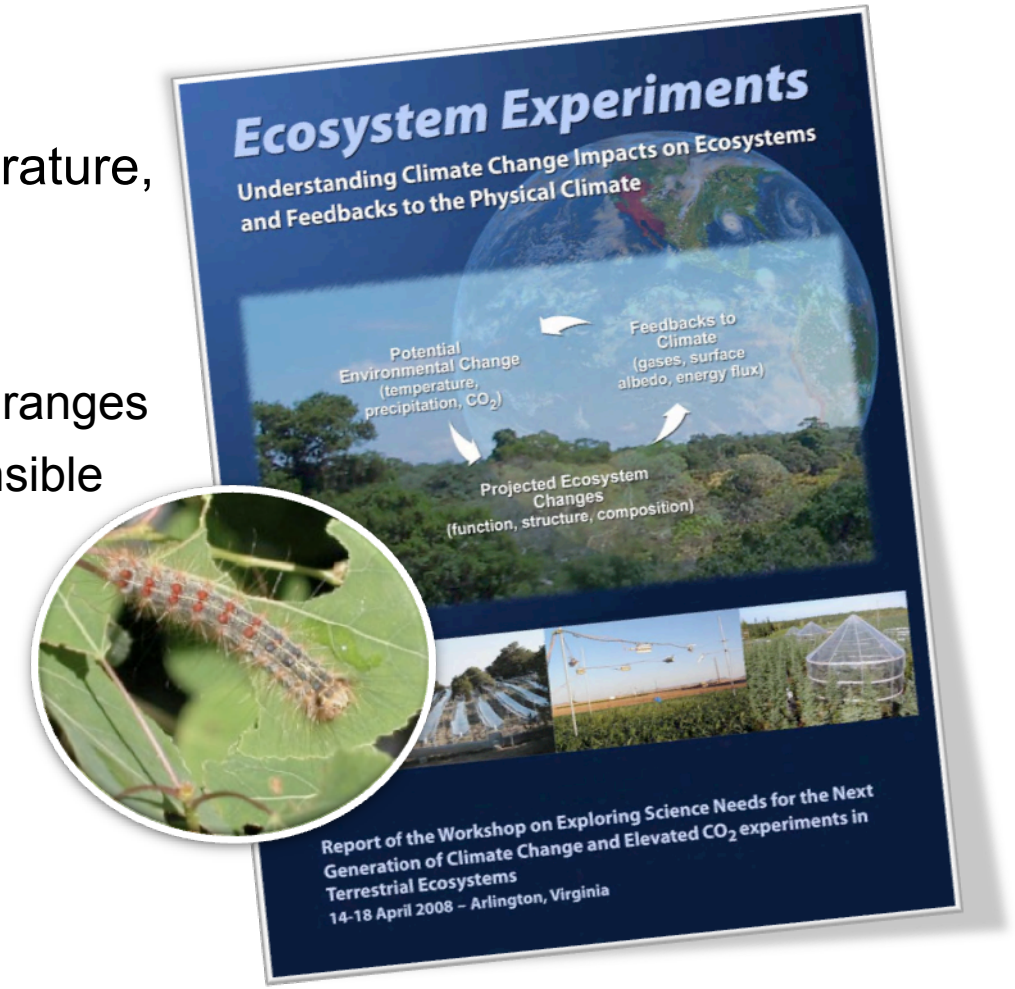
- Experimental and field-oriented program to:
  - Understand processes and mechanisms controlling the exchange of CO_2 between the atmosphere and terrestrial ecosystems
  - Develop process-based models
  - Improve reliability of global carbon models

- Basic research to understand how natural processes that control carbon sequestration in terrestrial vegetation and soils can be modified to enhance sequestration

CO_2 flux towers and instrumentation

Program for Ecosystem Research

- Develop and sustain unique, long-term, and ecosystem-scale experiments manipulating temperature, precipitation, and CO_2 levels
  - Quantify effects of warming on abundance of plant and animal species across their geographic ranges
  - Understand mechanisms responsible for plant mortality and altered plant-insect interactions induced by climate change
  - Quantify effects of warming on northward migration of plant species critical to ecosystem health



Subsurface research across scales

Integrative, multidisciplinary approaches to understanding multi-scale processes controlling contaminant mobility in the environment

- Characterization and monitoring
- Microbiology, geochemistry, hydrology
- Modeling and high-performance computing
- Molecular science, EMSL, light sources

Field Research

Field scale
$>10^3$ m

Mesoscale
$10^{1.5}$–10^3 m

Pore scale
10^{-3}–$10^{1.5}$ m

Microscopic
10^{-7}–10^{-3} m

Molecular/nano
10^{-10}–10^{-8} m

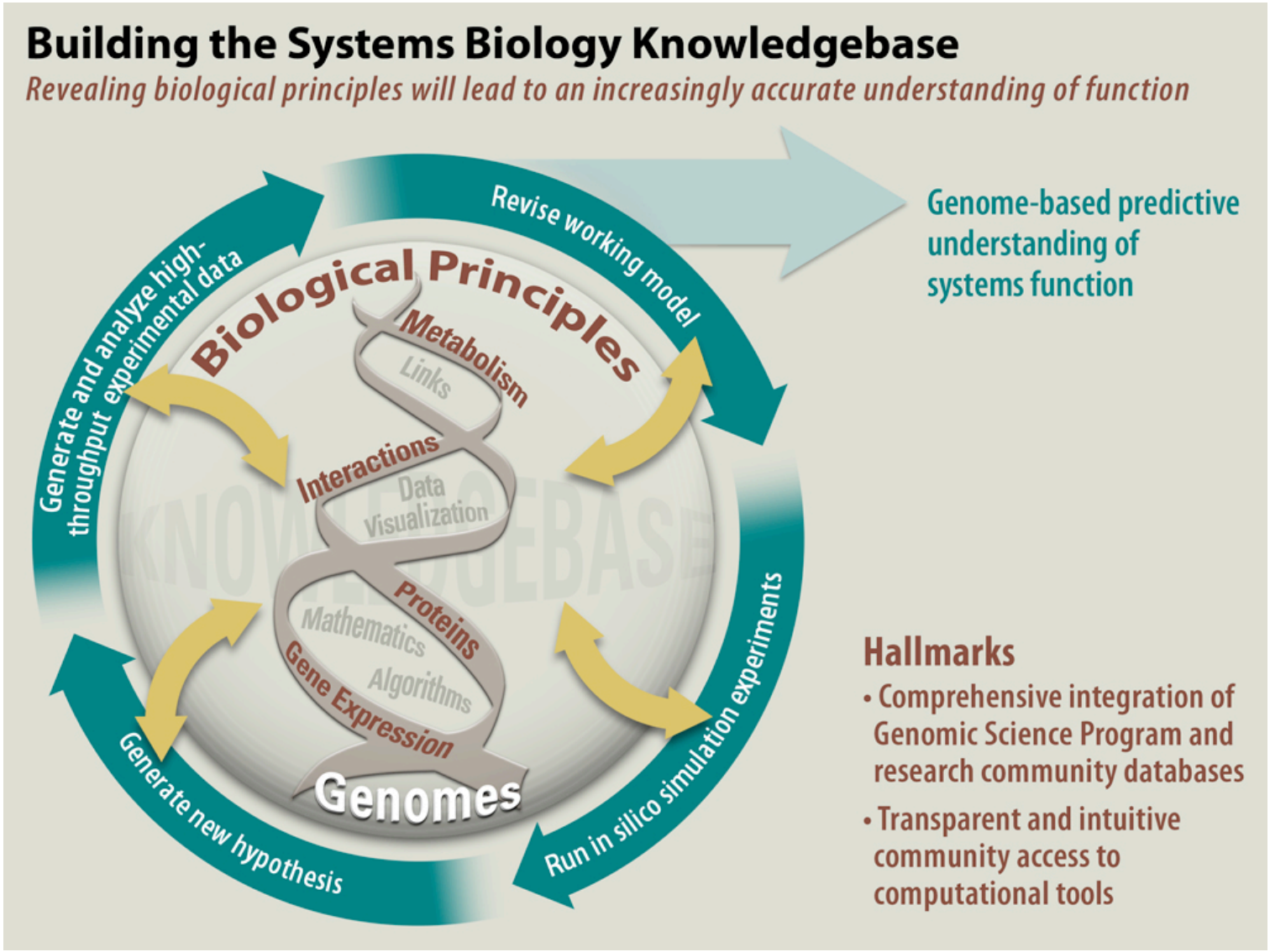
Scientific Discovery through Advanced Computing (SciDAC)

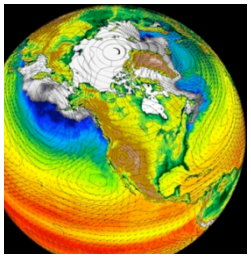
Leveraging the nation's intellectual investment in computational science for scientific discovery by conducting collaborative projects with the Office of Advanced Scientific Computing Research

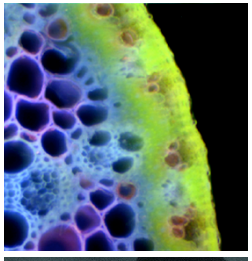
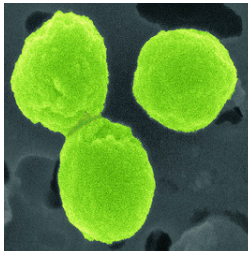
Climate change research	Genomics:GTL	Environmental remediation sciences
• Modeling how Earth's climate will respond to physical, chemical, and biological changes produced by global alterations of the atmosphere, ocean, and land	• Developing new methods for modeling complex biological systems – Molecular complexes – Metabolic and signaling pathways – Individual cells – Interacting organisms and ecosystems	• Developing more advanced models to better understand the movement of subsurface contamination

SciDAC
Scientific Discovery through Advanced Computing

Systems Biology Knowledgebase





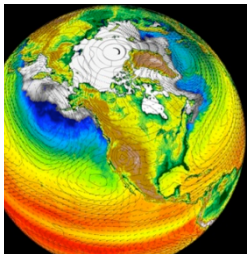




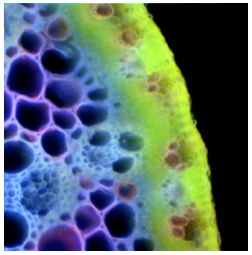
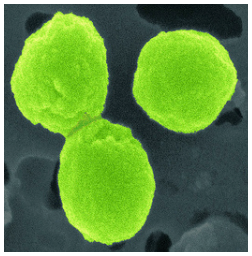
A Challenge and an Opportunity…

- Seems like we've been here before
- Biology is still waiting to be transformed
- What do we want to be talking about next time we meet?
- What can we do that will
  - Really get things started?
  - Make a real difference?
  - Get the community's attention
  - Lead the biological community?

Biological and Environmental Research

Complex systems science to meet DOE mission needs in bioenergy, climate, and the environment



Thank you!

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http://science.doe.gov/ober